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AVIATION PHYSIOLOGISTS BULLETIN

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ALTITUDE TRAINING PROGRAM IN THE EIGHTH AIR FORCE

As the greater proportion of American Aircrews arriving in the United Kingdom have already been processed in decompression chambers in the United States during their training period, there has been, in the Eighth Air Force relatively little altitude indoctrination per se. It has been necessary however to indoctrinate those who had not yet been and those who seemed so unfamiliar with the demand oxygen equipment that their lives (and those of their fellow crew-members) might be endangered under the operational conditions obtaining in combat missions over Germany.

These operational conditions are particularly trying and demand peak performance from both equipment and men. Formation flying is carried out between 22,000 and 30,000 feet, temperatures encountered are usually around -55 degrees centigrade and enemy opposition both from flak and fighters is on a scale hardly equalled elsewhere. These facts have determined the scope and direction of what altitude indoctrination there is in the Eighth Air Force.

Indoctrination of Bomber Crews:

Indoctrination in theatre operational conditions is undertaken at present at two separate Combat Crew Replacement Groups- one for B-17 crews and one for B-24 crews. The course of instruction which lasts about 10 days covers high altitude formation flying, use of special navigational devices, high altitude gunnery, etc. and 6 to 10 hours on individual and personal equipment and problems including oxygen, physiology of high altitude, air-sea rescue procedures, use of flying clothing and first aid in flight. The lectures on oxygen equipment are usually delivered by an Air Corps Officer who has been on combat or occasionally by a Flight Surgeon. Particular emphasis is placed on the following points:

- a. Fit of oxygen masks. With the A-10 series of masks this is a very serious problem, as active motion of the head almost always results in a certain amount of leakage. The problem of fit is becoming less acute with the advent of the A-14 mask.
- b. Freezing of oxygen masks. Always a serious problem with the constant flow masks (gunners have taken as many as five masks with them on a single mission and had four of these freeze up), a similar situation has again unexpectedly and unfortunately cropped up in regard to the A-14 and the A-10 series of masks. There have been at least six deaths to date due to freezing of the demand masks, four from the A-14 which has been in large scale use for about 3 months and two from the A-10 series in large scale use for about 12 months. The necessity for constant vigilance and manipulation of the masks to prevent freezing of inlet and outlet ports is stressed.
- c. Use of the automix. The normal position for the automix is "on."

Use of the automix "off" is forbidden unless the user is recovering from anoxia, moderately wounded, or exposed to exhaust or other toxic gases. In many groups it is customary to safety the automix to the "on" position with scotch tape to deter from use unless actually needed.

- d. Use of the emergency valve. The emergency valve is to be used only in case of an actual emergency; i.e., severe wounds, anoxia when artificial respiration is being given, or where the oxygen mask fits so badly that a slight flow is necessary. The danger of the prolonged use of the emergency valve is stressed strongly.
- e. Use of walk around bottle. Those available are described and the inadequacy of the A-4 stressed along with the danger of refilling a cylinder in flight because of the tendency of the filler valves to freeze open. (The Eight Air Force is committed to the use of the D-2 cylinder with A-13 regulator which can be used both as walk around and emergency oxygen supply should a line be shot out or a regulator damaged.)
- f. Anoxia. The symptoms and dangers of anoxia are pointed out and the fact that individuals can die from anoxia as well as from enemy action emphasized.
- g. Quick disconnect. Innumerable cases of anoxia and at least a dozen deaths due to anoxia have resulted from accidental separation of the mask tubing from the mask to the regulator hose. The quick disconnect must be checked and adjusted to a pull of approximately 14 lbs before each flight.

After the lectures a questionnaire is passed to the crews and those who have not been indoctrinated in the chambers and those who show evidence of inadequate information or misinformation are scheduled for chamber runs. Before the run the demand oxygen equipment is demonstrated and precautions in its use repeated. During the run the effects of changes of barometric pressure on ears, sinuses, gastro-intestinal tract, etc. are reviewed, and on reaching 30,000 feet each crew member is made to experience anoxia by disconnecting his mask. Each individual is then made to write his name and serial number until his writing becomes an illegible scrawl, and various questions are asked by the chamber operator or the other crew members. In this way incoordination, poor memory, etc. are graphically demonstrated. No mention is made of the change of color of the mucous membranes, ears or nail beds in anoxia as, generally speaking, they are not exposed to sight during high altitude flights in operational aircraft. Bends and chokes are mentioned merely en passant as they present no problem as yet, and the requirements of formation flying are such that descent implies getting out of formation, losing protection and getting shot down. The use of oxygen equipment is again emphasized from the practical standpoint and

particular emphasis placed on mask fit, quick disconnect etc.

Indoctrination of Personal Equipment Officer:

Personal Equipment Officers for the Eighth and Ninth Air Forces are all trained by the Eighth Air Force Central Medical Establishment of which the 41st Altitude Training Unit is part. These officers are practically all ground officers, and their training includes processing in the chambers and detailed discussion and instruction in the use of oxygen equipment. Indoctrination in the chambers is carried out in much the same way as it is for the air crews.

Examination of Central Medical Board Patients:

The Eighth Air Force has a Central Medical Board which examines and disposes of patients suffering from operational exhaustion, sinus trouble, recurrent attacks of aero-otitis, bends, low anoxia tolerance, etc. Where indicated these patients are run through the chamber under controlled conditions in order to check, insofar as possible, the basis and determining factors of their complaints and symptoms. The chamber runs have been found a rather useful adjunct to other examination procedures when used judiciously, and it has been possible to accumulate a certain amount of information on some unusual reactions to high altitudes.

Indoctrination in the Use of Special Equipment:

Pressure breathing equipment is being made available to certain selected groups of pilots flying on photographic reconnaissance missions at very high altitudes. The equipment is first checked by use in the chamber, and the pilots indoctrinated and roughly classified at the same time. It will probably not be necessary to continue this indoctrination for a very long time as the newer groups will have received their training in the United States.

Other Activities:

Along with indoctrination, certain other activities are undertaken by the personnel attached to the chambers, in close collaboration with the personnel of the Eighth Air Force Central Medical Establishment. This joint operation has resulted in temporary expedients to correct some of the unavoidable defects or deficiencies of oxygen equipment arriving from the United States and the devising of substitute equipment when there was a shortage of supplies. This has been a particularly fruitful function of the chambers.

While routine indoctrination of new crews will continue, this indoctrination in form and extent will be determined solely by whatever difference exists between training in the Zone of the Interior and operational requirements in Europe. It is anticipated, however, that, in the future, it will be possible to place increasing emphasis on the testing and development of new equipment and on the training of selected individuals in new techniques. Whatever other activities are undertaken will, as in the past, be determined by local situations and local problems.

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CAUSES OF ANOXIA IN COMBAT
AND ITS
FREQUENCY AMONG VARIOUS CREW MEMBERS

Reports received by the Air Surgeon's Office from the Eighth Air Force for the interval between 1 January 1944 and 15 February 1944 list 73 cases of unconsciousness due to oxygen lack during operational flights. Four incidents resulted in the death of the victim. This of course represents a very small percentage of the total missions flown during this interval, which speaks well for the efficacy of the Altitude Training Program.

All of the victims were using demand oxygen masks and had been previously indoctrinated in the use of the equipment and the dangers of anoxia. A relatively few causes were responsible for the majority of the incidents. The factors involved in these cases would seem to merit particular emphasis in oxygen indoctrination. In order of their frequency, they were:

Accidental unplugging of "quick disconnect"	22 cases (1 death)
Freezing of oxygen inlets into the mask	20 cases (2 deaths)
Poor judgment as to need for oxygen (Deliberate removal or disconnection of mask)	10 cases
Poorly fitting mask	7 cases
Faulty regulator (loose elbow, stuck diaphragm)	4 cases
Failure of oxygen supply	3 cases
Hose punctured by flak	1 case (death)
Cause unknown	6 cases
	<hr/> 76

The frequency with which anoxic incidents occur in various positions in the plane also indicates the directions where special emphasis may be required. The following 82 cases were reported from the Eighth Air Force during the interval of 1 January 1944 to 5 March 1944:

<u>GUNNERS</u>		<u>NON-GUNNERS</u>	
Ball Turret Gunner	30	Navigator	7
Waist Gunner	15	Bombardier	4
Tail Gunner	11	Pilots	3
Radio Operator	11	Engineer	1
	<hr/> 67		<hr/> 15

The high incidence of anoxia on the part of gunners is to be expected, since (1) their greater activity predisposes them to the accidental unplugging of the quick disconnect, while their attention has been distracted and (2) their exposure to severe cold leads to frequent freezing of the oxygen inlet into the mask.

The use of power driven turrets provides an additional complication.

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AVIATION PHYSIOLOGISTS

One class of Aviation Physiologists has been graduated from the School of Aviation Medicine since the last issue of the Bulletin. The graduates and their present assignments are as follows:

Class XIII, Beginning 21 February 1944

<u>Name and Rank</u>	<u>Degree</u>	<u>Station</u>
Chinn, Herman I., Capt., Sn.C.	Ph.D. 1938, Northwestern	Maxwell Field, Ala.
Ames, Smith W., 1st Lt., A.C.	M.A. U. of Maine	Santa Ana AAB, Calif.
Bickerman, Hylan A., 1st Lt., M.C.	M.D. 1939, U. of New York	Tonopah AAF, Nevada
Brower, Nathaniel, 1st Lt., A.C.	Ph.D. 1939, Cincinnati	Hamilton Fld, Calif.
Davidson, Floyd F., 1st Lt., M.A.C.	Ph.D. 1941, Texas	Laredo AAF, Texas
Greenberg, Ralph J., 1st Lt., M.C.	M.D. 1942, Illinois	MacDill Field, Fla.
Haertl, Edwin J., 1st Lt., A.C.	Ph.D. 1933, Harvard	Richmond AAB, Va.
Johnson, David F., 1st Lt., A.C.	Ph.D. 1937, New York	Harlingen AAF, Texas
Lewis, Harvey A., 1st Lt., M.C.	M.D. 1938, U. of S. Calif.	Santa Ana AAB, Calif.
Roman, Herschel L., 1st Lt., A.C.	Ph.D. 1942, Missouri	MacDill Field, Fla.
Schipper, Arthur L., 1st Lt., A.C.	Ph.D. 1937, Iowa	Dale Mabry Fld, Fla.
Barker, Shirley H., 2nd Lt., A.C.	Ph.D. 1942, Wisconsin	March Fld, Calif.
Huizinga, Henry, 2nd Lt., A.C.	M.A. 1933, Iowa	Santa Ana AAB, Calif.
Hetherington, Elbert W., Pvt., M.D.	Ph.D. Northwestern	SAM, Randolph Fld, Texas
Miller, Richard A., Pvt., M.D.	Ph.D. 1937, Iowa State	SAM, Randolph Fld, Texas

THE PROPHYLACTIC USE OF INTRANASAL VASOCONSTRICTOR
DRUGS IN SIMULATED HIGH ALTITUDE FLIGHTS

This study is an attempt to determine whether the prophylactic use of vasoconstrictor drugs given intra-nasally might decrease the incidence of aer-otitis due to simulated high altitude flights in the low pressure chamber. The drugs chosen for testing were ephedrine sulphate in 2% and neosynephrine hydrochloride in 0.25% aqueous solution. The experimental subjects were aerial gunnery students taking their routine indoctrination flight.

METHOD

After the subjects were seated in the chamber those on one side were arbitrarily chosen as the experimental subjects while those on the other side served as controls. The vaso-constrictor drug was administered through an atomizer by the inside observer. The nozzle was inserted into each nostril and the atomizer bulb compressed three times. After each subject had been so treated the process was repeated. It was hoped that the first administration by shrinking the turbinates might permit the drug to be sprayed farther back into the nasopharynx on the second administration. The chamber flight was that described as Type I in which an ascent to a simulated altitude of 30,000 ft. is made followed by a descent at a rate equivalent to a pressure change of 27 mm. of mercury per minute. The entire flight was of one hour duration. During descent all of the subjects, experimental and control, were frequently reminded to clear their ears. The observer noted on the reverse side of the flight cards which of the passengers had served as experimental subjects.

Within a few minutes of their emergence from the chamber the ears of all of the subjects were examined with an electric otoscope and the state of each drum noted. In order that the observations should be comparable, a set of criteria for describing the drums was established. Since the degree of retraction of a drum, or the degree of redness is difficult to estimate objectively they were not used as criteria. It had been observed previously that the regions of the drum exhibiting erythema appeared to be a good index of severity of involvement and since it also permitted fairly objective judgements, the criteria chosen were based on this observation. Degree of involvement was expressed in four grades. Grade I indicates redness limited to the membrane over the lateral process of the malleus, and Shrapnell's membrane. Grade II describes redness involving the above and in addition a portion of the tense part of the drum. The cone of the light is intact. In Grade III involvement the entire drum is hyperemic and the cone of light is not seen. In Grade IV involvement the picture is that of either II or III with the addition of bubbles or fluid. It is believed that by the use of these criteria differences in judgement by different observers are minimized. The examiners did not know which subjects had received the medication and which were controls. In tabulating the data the grade of involvement of the more severely affected ear was recorded for each subject. Since in many cases one drum

was severely affected while the other was uninvolved this seemed the best procedure.

RESULTS

Although the subjects were questioned about the presence of pain during descent the data so secured are not believed to be reliable and are not given. Since almost all of the students desire to be qualified for high altitude flying there is adequate motive for denying the presence of pain. That this is actually done is confirmed by our experience.

The data for the two vasoconstrictor drugs are summarized in tables I and II. In the ephedrine sulphate study objective involvement of the ear drum was seen in 29% of 693 treated subjects and in 30% of 831 untreated subjects. The difference is not statistically significant. Since Grade I involvement is minimal and usually asymptomatic practical considerations suggest that only cases showing Grade II to IV involvement should be considered as significantly affected. Such a degree of involvement was seen in 18% of the control subjects and in 19% of the treated. Again, the difference is not statistically significant. For each grade of involvement the differences between the treated and control subjects are not statistically significant.

Since the ephedrine sulphate study had shown that the results in the first fourth of the subjects were not significantly different from those of the total series, fewer subjects were used in the neosynephrine study. Of 212 treated subjects 25% showed objective ear drum involvement while 28% of 233 controls showed similar involvement. For summated Grades II to IV the incidence of involvement was 13% and 16% for the treated and control subjects, respectively. When the incidence of each grade of involvement in the treated and control subjects are compared by the chi-square test, only in Grade III are there significantly fewer cases in the treated subjects.

DISCUSSION

From the data presented it may be concluded that 2% aqueous ephedrine sulphate as administered in this study does not significantly decrease the incidence of aero-otitis in the low pressure chamber flight described. The very good agreement between the incidence of aero-otitis in the two groups indicates that they could have been drawn at random from the same population.

The lower incidence of Grade III aero-otitis after the use of neosynephrine hydrochloride suggests that the drug may prevent the severer grades of involvement, but it did not significantly decrease the over-all incidence of the condition. At any rate the effect appears to be too minimal to be of practical use.

It is concluded that ephedrine sulphate (1% aqueous) and neosynephrine hydrochloride (0.25% aqueous) when administered intranasally in a spray before low pressure chamber flights do not prevent aero-otitis. Any possible effect of the neosynephrine hydrochloride spray in preventing the severer grades of aero-otitis is so minor that its routine use for this purpose does not seem indicated. This does not imply the drugs may not be useful in those with acute upper respiratory infections.

It is probable that these conclusions will also hold for aircraft descents.

TABLE I
Ephedrine Sulphate (1% Aqueous)

Grade of Involvement	Control		Treated	
	No.	%	No.	%
None	583	70	493	71
I	85	10	65	9
II	85	10	71	10
III	71	8	51	8
IV	17	2	13	2
TOTAL	831	100	693	100

TABLE II
Neosynephrine Hydrochloride (0.25% Aqueous)

Grade of Involvement	Control		Treated	
	No.	%	No.	%
None	169	72	159	75
I	29	12	26	12
II	17	7	18	8.5
III	20	8	8	4
IV	2	1	1	0.5
TOTAL	233	100	212	100

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EDITORIAL NOTE:

It is recognized that the conclusions expressed in this article are at variance with the views of a number of aviation physiologists. It is believed

that several altitude training units are spraying the nasopharynx with vasoconstrictor drugs as a routine pre-flight procedure. If other units have data either confirming or contradicting the data in this article the Bulletin would be glad to receive them.

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IMPROVEMENTS IN THE PEPPERMINT OIL TECHNIQUE FOR TESTING THE FIT OF OXYGEN MASKS

The need for a simple, convenient and accurate method by which the fit of demand oxygen masks can be repeatedly tested while at altitude has been generally recognized. Repeated tests are required because an originally leak proof fit may subsequently develop a leak as a result of removal or manipulation of the mask. The "suction" test is inadequate to demonstrate small leaks and other tests are inconvenient to apply while at altitude.

The use of peppermint oil as a means of testing the mask fit prior to flights in the low pressure chamber has been a general practice at the School of Aviation Medicine. The aromatic material is held near the edges of the mask, and the presence of a leak is demonstrated when the odor can be detected. A benzedrine type of inhaler has been widely used as a convenient container for the peppermint oil. However, investigations carried out at the School of Aviation Medicine and at this unit have shown that 10-15% of the subjects who are fitted by this method, can be expected to show a leakage of greater than 5% when tested by the Scholander technique.

A variety of containers for applying this test had been studied at the School of Aviation Medicine. The most satisfactory device was found to be the 1/4 ounce urethral syringe which is a standard item of issue from Medical Corps Supply. A strip of filter paper or a small wad of cotton is saturated with peppermint oil and then inserted into the barrel of the syringe. The puff of air which is expelled from the syringe when the bulb is squeezed, provides a greater concentration of the fumes at the edges of the mask than can possibly be obtained as a result of their diffusion from an inhaler. The technique can be learned readily by inexperienced personnel, and can be self-applied easily and rapidly during flight to altitude.

Tests which have been performed at the School of Aviation Medicine and at this unit have shown that the syringe provides an extremely sensitive method for detecting mask leaks, even in the presence of considerable currents of air. The results are summarized in the following table:

% Leakage (Scholander)	Total	Leak detected by syringe	Leak not detected by syringe	% of subjects detecting leak
1% or less	226	26	200	11.5%
1.5% - 2.5%	46	23	23	50%
2.5% - 3%	25	17	8	68%
4-5%	53	46	7	87%
6-10%	27	26	1 (6%)	96%
Over 10%	15	15	0	100%
	<u>392</u>	<u>153</u>	<u>239</u>	

The superior accuracy of the syringe can be combined with the more convenient size and greater durability of the inhaler by using the internal barrel of the plastic benzedrine inhaler (Smith, Kline & French) with the rubber bulb of the urethral syringe (Merco).

At the present time, peppermint oil is difficult to procure, although its unrestricted sale to the armed forces has been authorized by the Department of Agriculture. Other essential oils (Beechwood, Cloves, Thymol, Geranium, Lavender and Wintergreen) may prove to be acceptable, if not perfectly satisfactory substitutes.

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AN ANOXIC EXPERIENCE IN THE EIGHTH AIR FORCE

While on a combat mission on the 3rd February 1944, the following incidents occurred: At 1010, at an altitude of 27,000 feet, prior to reaching the target, the ball turret gunner began to feel as if he was not getting enough oxygen. On investigation he discovered that one of the fittings of the quick disconnect coupling had pulled loose from the hose. He attempted to put it back together; but as he worked he became more and more nervous: and before he was able to get the hose onto the coupling he lost consciousness.

The navigator called all stations on the interphone at 1015 to make an oxygen check. The ball turret gunner failed to answer. The navigator ordered the left waist gunner to check up on the ball turret gunner. The left waist gunner disconnected his oxygen supply hose from the main line and connected up with

an A 4 special walk-around bottle. He got over as far as the ball turret when he felt that he was not getting enough oxygen so he returned to his own station and re-connected his hose to the main oxygen outlet at his station.

The radio man saw that the left waist gunner was having some difficulty so he tossed a D 3 walk-around bottle to the right waist gunner. The latter disconnected his own oxygen supply from his station outlet, plugged into the D 3 walk-around bottle and started to the ball turret. Here he disconnected his own hose and tried to connect the walk-around bottle with the ball turret gunner's hose. This, having a faulty connection at the quick-disconnect junction, did not work and the right waist gunner lost consciousness. The radio man, viewing this procedure tried to help both unconscious men (the right waist gunner and the ball turret gunner) by walking down with his long hose remaining connected to his station outlet. In doing this he stretched his oxygen hose so that he was not getting enough oxygen. He started to return to the radio room and lost consciousness.

The bombardier picked up two A 4 special walk-around bottles from the nose and started back through the bomb bay to help the crew men. He was changing his oxygen hose from one bottle to the other in the bomb bay just as the ship was nearing the target. The bomb bay doors began to open so the bombardier dropped both walk-around bottles and ran for the radio room. He just reached the radio room and lost consciousness.

As soon as the bombs were released over the target the pilot dove the ship from 25,000 feet down to 5,000 feet. Also as soon as the bombs were released the co-pilot went back in the ship to try to assist the men suffering from anoxia. All of the men regained consciousness shortly after the plane began to lose altitude. The co-pilot gave artificial respiration and emergency oxygen to the ball turret gunner approximately twenty minutes - or all during the time the plane was descending from 25,000 feet to 5,000 feet.

Because of the number of persons unconscious and the high degree of excitement, it was impossible to obtain accurate time interval from the men. It is believed that:

The ball turret gunner was unconscious about one hour and 10 minutes, about 40 to 45 minutes of that time at 27-28,000 feet.

The right waist gunner was unconscious for about 20 minutes at 28,000 feet.

The left waist gunner was not totally unconscious but was anoxic for a period of about 15 minutes at 28,000 feet.

The radio operator was unconscious for approximately 15 minutes at 28,000 feet.

The bombardier was unconscious from 10 minutes at 28,000 feet.

All men were using the regulator A-14 demand system oxygen masks. It is thought that two factors contributed to the accident:

1) The oxygen line on the right side of the ship from which the A 4 walk-around bottles were filled had given some trouble previous to that trip, and was believed by the crew to be leaking.

2) Two members of the crew believed that the regulators on the A 4 were not functioning.

On a subsequent mission flown in the same ship, the entire right side oxygen supply went out completely.

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